APPLICATION NO. 10/806,016

INVENTION: Multi-scale code division frequency/wavelet multiple access

INVENTORS: Urbain Alfred von der Embse

Currently amended CLAIMS

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WHAT IS CLAIMED IS;

Claim 1. (currently amended) A ~~means~~ method for ~~the design~~implementation of new multi-resolution complex Wavelet waveforms ~~in~~ the Fourier domain, and for ~~the design~~implementation ~~of~~ new orthogonal Wavelet division multiple access OWDMA filter banks, ~~with these Wavelets with properties which~~ said method comprising:

using ~~provide a means for the~~ complex extensions of the Wavelet concept to the Fourier frequency domain with ~~the~~ addition of frequency translation as a Wavelet parameter to ~~the~~ existing scale (dilation) and translation (shift) parameters for Wavelets~~.~~;

using ~~provide a means for the~~ a single multi-resolution complex Wavelet ~~design~~ implementation for ~~all of the~~ Wavelets at multiple scales, frequencies, and translations;

using a~~provide a means for~~ multi-resolution complex Wavelet ~~design methodologies~~implementation ~~that~~ to circumvent ~~the~~ a need to apply ~~the~~ current methodology to use a Wavelet iterated filter bank construction to ~~obtain~~ generate ~~the~~ a Wavelet, and ~~the~~to apply ~~current~~ methodology to generate ~~the~~ a Wavelet as a function of the scaling functions, and ~~that provide a means for~~said implementation provides flexibility to meet ~~the~~ application goals;

using ~~provide a means for the design of~~ new orthogonal OWDMA filters and filter banks ~~using~~ implemented with multi-resolution complex Wavelet channelization waveforms ~~designed~~ generated in the Fourier domain, and which can include analytical and iterated filter bank construction design techniques;

using implementations ~~provide a means~~ for ~~the design of new~~ orthogonal OWDMA filters and filter banks over contiguous and non-contiguous frequency bands, ~~and~~ for simultaneous multi-resolution OWDMA filters at different scales and different frequencies and different symbol rates, ~~and~~ said implementations using multi-resolution complex Wavelet channelization waveforms ~~designed~~ generated in the Fourier frequency domain and which can include analytical and iterated filter bank construction ~~design~~ techniques;

~~provide~~ using a ~~means for the design of the~~ mother multi-resolution ~~Wavelet~~ at dc ~~in~~ the Fourier frequency domain ~~and~~ ~~a means for~~ constructing ~~the~~ a desired multi-resolution complex Wavelet from ~~this~~ said mother Wavelet using appropriate scale, frequency, and translation changes to the mother Wavelet; and

implementing said OWDMA filters in a communications transmitter and in a communications receiver for a communications link.

Claim 2. (currently amended) A ~~means~~ method for ~~the design~~implementation of new multi-scale complex code division multiple access MS-CDMA ~~encoding~~ and decoding over multiple scales where each scale corresponds to an independent communications parameter, ~~and~~ which MS-CDMA encoding includes the complex pseudo-noise spreading or covering, and which MS-CDMA decoding includes removal of this complex pseudo-random spreading or covering, said method comprising: ~~and which~~

using ~~provide a means for~~ complex orthogonal MS-CDMA encoding spreading over a frequency band with a lower chip rate than the chip rate using current CDMA encoding;

using ~~provide a means for~~ complex orthogonal MS-CDMA encoding spreading over a non-contiguous frequency band ~~with~~ a lower chip rate than the chip rate using current CDMA encoding;

~~provide~~ using ~~a means for controlling the~~ power level ~~of~~ control of the transmitted signal as a function of the frequency over the frequency band;

~~using~~ using ~~provide a means to implement the~~ fast complex MS-CDMA encoding ~~and~~ decoding over multiple scales, and which MS-CDMA ~~includes~~ the complex pseudo-noise spreading or covering and the removal of the complex pseudo-random spreading or covering;

~~provide a means to~~ partitioning the frequency band into independent subbands or groups of subbands and ~~to~~ MS-CDMA ~~encode~~ encoding and spreading the users over these subbands or groups of subbands;

~~provide a means to~~ partitioning the frequency band into independent subbands or groups of subbands, ~~and~~ assigning ~~the~~ users to the subbands or groups of subbands, and ~~to~~ MS-CDMA ~~encode~~ encoding and spreading the users within their assigned subbands or groups of subbands;

~~provide a means to implement a 2 scale MS-CDMA to assign the users to subband groups and to MS-CDMA encode and spread each set of users in these groups such that each user in the group is spread over all of the subbands in the group in a scale 1 encoding and spreading and is spread within each subband of the group in a scale 0 encoding and spreading and provide a means for implementing fast encoding and decoding algorithms~~

implementing ~~provide a means a means to implement~~ a 2 scale MS-CDMA ~~to assign~~and assigning the subbands over a frequency band into MS-CDMA groups, ~~and to~~ MS-CDMA ~~encode~~ encoding and spreading each user in ~~a~~ each group such that each user is spread within each subband in the MS-CDMA group in a scale "0" encoding and spreading, ~~each user in each group~~and is spread over the subbands of the MS-CDMA group in a scale "1" encoding, and spreading and ~~provide a means for~~ implementing fast encoding and decoding algorithms;

using a ~~provide a means to exploit the separability of the~~Kronecker product (tensor product) for generating a ~~complex~~

orthogonal 2-~~-~~scale MS-CDMA code matrix as a ~~generalized~~ Kronecker product of a subband complex orthogonal MS-CDMA code matrix for scale "0" encoding and spreading and a wideband complex orthogonal MS-CDMA code matrix for scale "1" encoding and spreading, ~~-~~and ~~provide a means for~~ implementing fast encoding and decoding algorithms,

using ~~provide a means to exploit the separability of the complex orthogonal multi-scale MS-CDMA code matrix as generalized Kronecker products of~~ Kronecker product (tensor product) for generating a complex orthogonal N-scale MS-CDMA code matrix as a Kronecker product of orthogonal complex MS-CDMA code matrixes for each of the MS-CDMA scales "0", "1", . . . ~~.~~, "N-1", ~~and~~ with each scale assigned to an independent communications parameter, ~~and~~ with each scale performing encoding and spreading of the users, and ~~to provide a means for~~ implementing fast encoding and decoding algorithms,

using an algebraic field factorization and scaling to convert a CDMA code matrix to a 2-scale CDMA code matris by

generating a CDMA code with a code length equal to a product of a number of chips for a first scale "0" CDMA encoding having first code and chip indices used to encode data symbols within each subband, and a number of chips for a second scale "1" CDMA encoding having second code and chip indices used to encode data symbols over the entire set of subbands,

forming a 2-scale CDMA code by assigning code and chip indices such that the 2-scale CDMA code and chip indices are the algebraic addition of the first sca;e "0" code and chip indices plus scaled second scale "1" code and chip indices, wherein said scaled indices are generated using a scale factor that comprises the number of indices in the first scale CDMA code,

wherein the steps of generating and forming further include encoding data symbols with the 2-scale CDMA code to generate encoded chips,

assigning each of the encoded chips to a subband in accordance with the second scale "1" CDMA code indices, assigning each encoded chip to a chip position within its assigned subband in accordance with the first scale "0" CDMA code indices, and encoding with pseudo-noise covering, and generalizing said implementation to scales "0", "1", . . , "N-1" for an N-scale MS-CDMA code matrix ~~provide a means for generating a complex orthogonal multi-scale MS-CDMA code matrix which exhibits the separability property that allows the MS-CDMA code matrix to be separable into a generalized outer product of 2 or more complex orthogonal MS-CDMA code matrices for encoding spreading at each of the scales and~~ with each scale assigned to an independent communications parameter, ~~and~~ with each scale performing encoding and spreading of the users, and ~~to provide a means for~~ implementing fast encoding and decoding algorithms; and

implementing said N-scale MS-CDMA in a communications transmitter and in a communications receiver for a communications link.

Claim 3. (currently amended) A ~~means~~ method for ~~the design of~~ implementing new multi-scale complex code division multiple access MS-CDMA ~~orthogonal~~ frequency division multiple access OFDMA communications, ~~and a means~~ for ~~the design of~~ implementing new ~~MS-CDMA~~ orthogonal Wavelet division multiple access OWDMA communications, ~~and~~ which MS-CDMA encoding includes ~~the~~ pseudo-noise complex spreading or covering, and which MS-CDMA decoding includes removal of this pseudo-random complex covering or spreading, ~~and which~~said method comprising:

using ~~provide a means for~~ MS-CDMA encoding and spreading of ~~the~~ users over ~~the~~ OFDMA or OWDMA channels in a frequency band which may be non-contiguous;

using ~~provide a means for~~ MS-CDMA encoding and spreading of ~~the~~ users in ~~the~~ OFDMA or OWDMA channels over a frequency band which may be non-contiguous;

using ~~provides a means for~~ MS-CDMA encoding and spreading of the users within each ~~of the~~ OFDMA or OWDMA channel~~s~~ and over all of ~~the~~ OFDMA or OWDMA channels such that each user is in each ~~of the~~ OFDMA or OWDMA channel;

~~provide a means for~~ implementing fast encoding and decoding algorithms for ~~the~~ complex MS-CDMA;

~~provide a means for~~ implementing fast algorithms for ~~the~~ a multi-resolution complex Wavelet transform for OWDMA encoding and ~~a means for~~ implementing fast algorithms for ~~the~~ multi-resolution complex Wavelet transforms for OWDMA decoding;

using ~~provide a means to implement~~ a 2 scale MS-CDMA OFDMA or MS-CDMA OWDMA ~~to~~ assigning ~~the~~ users to channel groups and ~~to~~ MS-CDMA ~~encode~~ encoding and spreading each set of users in these groups, such that each user in ~~the~~ a group is spread over all of the channels in ~~the~~ a group in a scale "1" encoding and spreading, and is spread within each channel of ~~the~~ a group in a scale "0" encoding and spreading, and ~~provide a means for~~ implementing fast encoding and decoding algorithms;

using a Kronecker product for constructing ~~provide a means for generating~~ a complex orthogonal multi-scale MS-CDMA code matrix ~~which exhibits the separability property that allows the MS-CDMA code matrix to be separable into a generalized outer product of 2 or more complex orthogonal MS-CDMA code matrices~~ for encoding spreading at each of the scales, ~~and~~ with each scale assigned to an independent communications parameter, ~~and~~ with each scale performing encoding and spreading of the users, and with one or more scales assigned to OFDMA or OWDNA;

using an algebraic field factorization and scaling for constructing a complex orthogonal multi-scale MS-CDMA code matrix for encoding spreading at each of the scales, with each scale assigned to an independent communications parameter, with each

scale performing encoding and spreading of the users, and with one or more scales assigned to OFDMA or OWDNA; and

implementing said MS-CDMA OFDMA and MS-CDMA OWDMA filters in a communications transmitter and in a communications receiver for a communications link.